

Agricultural Chemicals and Public Health

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POTENTIAL HAZARDS as well as obvious benefits to the public health result from the manufacture and use of agricultural chemicals.

Among the hazards are the excessive exposure of workers who manufacture, formulate, or apply the materials; the accidental exposure of children or other irresponsible persons; and the exposure of the general population in the event that residues on food should ever be allowed to approach the toxic level.

However, few accidents occur if instructions for the use of the chemicals are followed and the prescribed precautions are taken.

The public health benefits from the use of agricultural chemicals should always be kept in mind in considering the potential hazards involved in the use of these materials. These benefits include improved nutrition and shelter, which result from increased production of food and fiber. Furthermore, some of the so-called agricultural chemicals have fostered health through the control of malaria and other vector-borne diseases (1). Certain fertile areas, notably the Pontine Marshes in Italy, which once were practically uninhabitable because of malaria, now support healthy farm families and a thriving agriculture. In many other areas where farming has been carried on for cen-

turies, the health of the farmers has been improved since the use of insecticides (2).

Toxicology of Agricultural Chemicals

The results of using cottonfield insecticides in the Mississippi Delta were investigated by Fowler (3) to determine whether the large-scale use of the newer insecticides presented a toxic hazard to the population of that region. The study area included one small city where questions similar to those raised by Biskind (4-7), Biskind and Bieber (8), Merkin (9), and Scott (10) had been asked by one physician. It was suggested that insecticides might be at least the contributing cause of fungus infection, hay fever, asthma, sinusitis, gastrointestinal upsets, dehydration, alkalosis, malnutrition, pneumonitis, cancer, poliomyelitis, arteriosclerosis, heart disease, and insanity.

All physicians in the study area were urged through their medical societies to report cases of suspected insecticide poisoning. Other groups, including hospital staffs, county agricultural agents, and civic clubs, were approached for the same purpose. As was anticipated, a few cases of acute poisoning by parathion and several chlorinated hydrocarbon insecticides were reported, and a few others were uncovered by Fowler in an epidemiological survey of 83 farm laborers and a survey of 639 unselected persons living on a large plantation. The cases of poisoning were all caused by excessive exposure to the insecticides and were frequently associated with gross carelessness on the part of workers.

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In addition to direct clinical studies, Fowler reviewed school attendance records, mortality records of the delta and of the State as a whole, and morbidity records of a plantation hospital. He also sought the expert judgment of county health officers. He compared the incidence of disease in these areas during the periods before and after the introduction of the newer agricultural chemicals. He also compared the incidence of disease in the regions of the State of Mississippi where insecticides are little used with the disease incidence in the delta, where cotton culture necessitates the extensive use of agricultural chemicals. In all of the studies, no evidence could be found that pesticides were the direct or indirect cause of any chronic disease or a contributing factor in diseases generally recognized as having other etiologies.

In Washington State, although no cotton is raised, many of the problems faced by orchardists around Wenatchee are similar to the problems faced by cotton farmers in places where the fields are near many residences. Agricultural chemicals must be used extensively in order to produce marketable apples and cotton, and there are many situations in which agricultural lands adjoin the suburbs of a town.

Sumerford and his colleagues (11) studied the cholinesterase response and symptomatology from exposure to organic phosphorus insecticides in the Wenatchee district. Emphasis was placed on parathion and tetraethylpyrophosphate because preliminary evidence indicated that these compounds were frequently the cause of illness among workers who used them. However, DDT was usually included in the formulation with these compounds. The amount of DDT used was considerably greater than the amount of organic phosphorus insecticides (12) employed in spraying fruit trees, and the clinical studies gave an opportunity to detect injury from DDT if such injury existed.

The persons studied were divided into eight groups. Three groups (mixing-plant personnel, commercial applicators, and part-time applicators) had extensive exposure. Two other groups had definite, although often minimal and irregular, exposure. A sixth group was made up of residents who lived in or near orchards but had no known occupational contact with insecticides; actually, most of them lived in

orchards with trees on two or three sides of the house. A seventh group was composed of persons who lived more than 500 feet from orchards and had no occupational contact with insecticides. The eighth group included persons living completely outside of the fruit-growing areas.

The average cholinesterase values for groups of persons known to have definite and consistent exposure to insecticides showed significant reduction during the period of contact. No significant reduction in cholinesterase values was found for the groups who made little or no use of the compounds. Although extensive day-to-day exposure was regularly associated with reduced blood cholinesterase, the only fatal and near-fatal cases found were associated not with long-standing use but with brief, massive exposure.

Although a considerable number of mild illnesses caused by organic phosphorus insecticides were found, it is important that even these mild illnesses followed extensive occupational use of insecticides. Further study by investigators at the Wenatchee Field Station has confirmed that persons who live near orchards do not get enough incidental exposure to cause illness. Moreover, the slight illnesses which workers did get as the result of overexposure were not capricious; they resembled severe poisoning in every way except that they were briefer and milder. Thus, the findings of Sumerford and his colleagues (11) confirm the findings of Fowler (3).

Classification of Hazards

Hazards associated with agricultural chemicals may be classified as follows:

1. Hazards of manufacture or formulation.
2. Hazards of mixing or application.
3. Hazards to persons not directly associated with the chemicals.
 - a. Children and irresponsible adults.
 - b. Persons whose food is contaminated by residues of the chemicals.
 - c. Persons exposed incidentally.

Fowler (3), in his study in a cotton-growing area, encountered accidents involving mixing and application of insecticides and two cases of



U. S. Department of Agriculture photograph.

mild poisoning associated with the direct application of parathion to a house.

Sumerford and his colleagues (11), working in another area where insecticides are used extensively, found cases of poisoning in all three classifications, specifically, in formulators, applicators, and children who accidentally ingested insecticides.

It should not be supposed that these studies indicate any basically new development. Poisoning in all of these classifications has long been known for the older pesticides. Each chemical carries its own peculiar danger. Both acute and chronic lead poisoning are well-recognized clinical entities. Chronic lead poisoning, either mild or severe, is less frequent than in the past. However, lead poisoning has been reported (13) since the introduction of the newer insecticides, and whenever lead is used it presents a constant danger. Pyrethrum is in a completely different class so far as toxicity and hazard are concerned, but to emphasize that no material is safe under all conditions, it need only be recalled that pyrethrum has been the cause of anaphylactic reactions.

Compared with the older materials, the safety record of the newer agricultural chemicals is good (14). However, human cases are on record of essentially uncomplicated, acute poisoning by the following newer agricultural chemicals: chlorinated hydrocarbon insecticides—aldrin, chlordan, DDT, lindane, and toxaphene; organic phosphorus insecticides—demeton (Systox), Isopestox, paraoxon, parathion, and tetraethylpyrophosphate; and rodenticides—sodium



U. S. Department of Agriculture photograph.

fluoroacetate (1080), and warfarin. Moreover, the heavy metals may be as dangerous when used for new purposes as they were for old purposes. We have records of poisoning by arsenicals used as herbicides and by mercurials used for fungicidal seed treatments.

Accurate diagnosis of poisoning by newer agricultural chemicals has been made possible by a study of human cases. Obviously, severe poisoning is more easily diagnosed than mild involvement, but except in very specialized situations, diagnosis presents no problem in industry and agriculture or among children who accidentally ingest pesticides. In these instances, the problem, although relatively small, is clearly recognized. Steps to reduce it to a minimum are in order.

Greater emphasis needs to be given to the importance of careful reading of labels. The labels, which are subject to State and Federal control, are the product of careful thought. Accidents with pesticides which do not involve a violation of the instructions and precautions on the label are extremely rare. However, the mere reading of labels is not enough. Each agricultural laborer must be made to understand the reason for precautions in handling insecticides. Proper training may present very real difficulty when laborers are illiterate or when there is a language barrier between them and their supervisors. However, adequate training is the moral responsibility of the employer and the foreman. Such training will be rewarded by fewer accidents and less economic loss.

Recent studies in the Wenatchee, Wash., area

(15) indicate that the potential hazard of parathion to spray personnel is greater by the dermal than by the respiratory route. This finding provides a stimulus for more widespread use of protective clothing, but it does not in any way lessen the need for the use of respirators by persons engaged in parathion application. Particulate matter generally is irritating to the respiratory tract, and this alone is adequate reason for wearing a respirator during mixing operations and in other situations involving a high dust concentration.

Accidents to Children

It is easy to say that potentially dangerous materials, whether aspirin or rat poison, should be kept out of the way of children, but to accomplish this requires continued education and constant attention. In many areas, more children are poisoned by kerosene than by any other single material, and additional cases of poisoning are caused by solvents in paints and polishes. As a class, drugs cause more poisoning, both fatal and nonfatal, in the household than other chemicals, the number being about equal to the number of cases involving all other kinds of chemicals common in the household (16). The fact that pesticides as a group cause fewer household accidents than some other materials offers little comfort. The record shows that in most instances in which children have been poisoned by pesticides (lindane, parathion, tetraethylpyrophosphate, sodium monofluoroacetate) the tragedy involved a child of the person who owned the compound.

Over and above the personal tragedy, poisoning in children is interrelated with other problems involving hazards to third persons. Once an accident has occurred, the injury to public relations has been done. Recently, two children were killed by ingesting tetraethylpyrophosphate (TEPP). As a direct result of their deaths, the Technical Development Laboratories at the Communicable Disease Center has received correspondence inquiring why the use of such a poisonous material as TEPP is permitted. It is unreasonable to expect the general public to know that this particular chemical hydrolyzes rapidly after it has been applied to fruit trees and that when it is used properly it presents no residue problems. Furthermore,

most organic phosphorus insecticides do not hydrolyze so rapidly, and under practical conditions a few of them remain active for months.

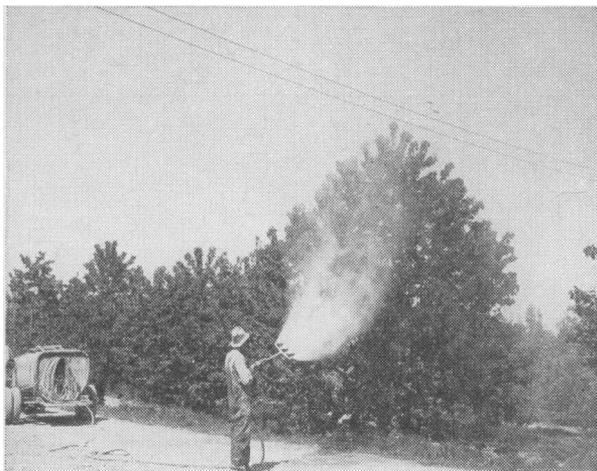
The potential hazard of residues of chemicals in foods has little relation to food products obtained from cotton. It is true that cottonseed oil is extensively used as food and that cottonseed meal is used as feed for livestock. However, the residues of most agricultural chemicals remain external on the plant, and the systemic organic phosphorus insecticides have been proved not to be a practical problem so far as cottonseed is concerned.

Incidental Exposure

The potential hazards from incidental exposure to pesticides require special consideration. By incidental exposure is meant any exposure which is neither voluntary nor strictly accidental. Thus, incidental to treating a crop, some pesticides may fall in neighboring fields or suburbs without there being any intent to treat those areas and without there being any accident in the usual sense.

Evidence has been presented by Fowler (3), Sumerford and his associates (11), Barnes (17), and others that under ordinary conditions persons exposed incidentally to pesticides do not contact enough of the materials to cause any injury. However, complaints continue to be heard from certain areas. These complaints show a striking variation from one locality to another, and they appear to bear no strict relationship to the amount of pesticides used in the area or, in fact, whether pesticides are used at all.

One community reached near hysteria largely because it was suspected that the deaths of two infants were caused by incidental exposure to organic phosphorus insecticides. Spraying and dusting of trees had been done in the neighborhood and the odor of insecticides was evident. Epidemiological and clinical studies by the Public Health Service failed to show evidence that incidental exposure was the cause of disease. Alarm was dispelled, although the study did reveal cases of poisoning associated with occupational exposure, and investigation was made of several cases in which children swallowed poison with fatal or near-fatal results (18).



Soil Conservation Service photograph.

In two other instances, complaints apparently could be traced to a single person in each community. A study in one community and a public explanation in the other served to reduce the complaints, if not to eliminate them completely. However, an investigation or a public statement will not solve each local problem. In one State, although complaints are less frequent, they have continued after a joint investigation of the use of pesticides by the Public Health Service and the State health department.

It is doubtful if any single reason for success or any single reason for failure to reduce these complaints can be found. For several years, the natural tendency to blame certain illnesses on pesticides has been aggravated by articles in magazines and newspapers, which have failed to recognize the fact that, in large populations, poisoning can be expected to appear most quickly, most frequently, most diversely, and most severely in those persons most extensively exposed to these compounds. The factory workers and farmers who come in contact with chemicals constitute large populations, and it is significant that the cases of poisoning which have occurred were almost all acute and were all the result of definite exposure.

The varied claims of injury from incidental exposure to agricultural chemicals present a problem which can be met chiefly by correct diagnosis of each case. The fact that the studies made so far have failed to reveal injury from incidental exposure to these chemicals does not

necessarily indicate that injury would not be revealed under different conditions. In any event, careful diagnosis of each case of suspected insecticide poisoning and a reasonable regard for the principles of epidemiology remain a crucial responsibility of every physician, whether he be in private practice or in the practice of public health.

Community Approach

From the community standpoint, there is a mature and an immature approach to the use of agricultural chemicals. Maturity may be measured by the degree to which citizens are aware of the different factors influencing the community and the degree to which they cooperate for the mutual good. In the mature, basically agricultural community, the necessity for using agricultural chemicals is accepted, as is the potential danger which some of these materials bring to those who use them. Partly because this problem of hazard to the worker has been met forthrightly, the safety record is good. Each grower takes direct, personal responsibility for the chemicals to be used and the amount, method, and timing of their application. Neighbors are advised when insecticides are to be applied and recognize the necessity for their use.

REFERENCES

- (1) Hayes, W. J., Jr., and Simmons, S. W.: Benefits and hazards of insecticides to public health. *Advances in Chemistry Series*, No. 1: 56-60 (1953).
- (2) Simmons, S. W., and Upholt, W. M.: Disease control with insecticides. *Bull. World Health Organization* 3: 535-556 (1951).
- (3) Fowler, R. E. L.: Insecticide toxicology. Manifestations of cottonfield insecticides in the Mississippi Delta. *Agri. and Food Chem.* 1: 469-473 (1953).
- (4) Biskind, M. S.: DDT poisoning and X-disease in cattle. *J. Am. Vet. Med. A.* 114: 20 (1949).
- (5) Biskind, M. S.: DDT poisoning a serious public health hazard. *Am. J. Digest. Dis.* 16: 73 (1949).
- (6) Biskind, M. S.: DDT poisoning and the elusive "virus X": A new cause for gastro-enteritis. *Am. J. Digest. Dis.* 16: 79-84 (1949).
- (7) Biskind, M. S.: Public health aspects of the new insecticides. *Am. J. Digest. Dis.* 20: 331-341 (1953).

- (8) Biskind, M. S., and Bieber, I.: DDT poisoning—a new syndrome with neuropsychiatric manifestations. *Am. J. Psychotherapy* 3: 261-270 (1949).
- (9) Merkin, S.: Warning: Poison in milk! *Nat. Police Gaz.* 159: 8-9 (1954).
- (10) Scott, A. E.: Health foods doorway to death. *Sir* 11: 44-45, 62-64 (May 1954).
- (11) Sumerford, W. T., Hayes, W. J., Jr., Johnston, J. M., Walker, K., and Spillane, J.: Cholinesterase response and symptomatology from exposure to organic phosphorus insecticides. *A. M. A. Arch. Indust. Hyg. and Occup. Med.* 7: 383-398 (1953).
- (12) Batchelor, G. S.: Survey of insecticide spray practices used in the fruit orchards of north central Washington. *A. M. A. Arch. Indust. Hyg. and Occup. Med.* 7: 399-401 (1953).
- (13) Farner, L. M., Yaffe, C. D., Scott, N., and Adley, F. E.: The hazards associated with the use of lead arsenate in apple orchards. *J. Ind. Hyg. & Toxicol.* 31: 162-168 (1949).
- (14) Simmons, S. W., and Hayes, W. J., Jr.: Relative toxicity of insecticides. *Soap and San. Chem.* 27: 148-150 (1951).
- (15) Batchelor, G. S., and Walker, K.: Health hazards involved in the use of parathion in fruit orchards of north central Washington. Presented at meeting of the Entomological Society of America, December 7-10, 1953.
- (16) Hayes, W. J., Jr.: Hazards in the use of insecticides. Proc. 39th mid-year meeting Chemical Specialties Association. Pp. 95-97, 1953.
- (17) Barnes, J. M.: Toxic hazards of certain pesticides to man. *Bull. World Health Organization* 8: 419 (1953). Reprinted: World Health Organization Monograph Series No. 16.
- (18) Johnston, J. M.: Parathion poisoning in children. *J. Pediatrics* 42: 286-291 (1953).

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